



## Nuclear Chart Exercises

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### Exercises

1. Neutron emitters in the standard colour scheme.

How many nuclides are neutron emitters?

By using the "decay mode filter" option, answer the same question?

What are the other decay modes with a neutron emission?

For the pure neutron emitters, there is the case of a multi-emission with two or three neutrons. Find the nuclides with such a decay mode.

What is the typical half-life of such nuclides?

The other modes are known as beta delayed decays. This means that the emission of neutrons follows a  $\beta^-$  decay. The neutron multiplicity may also be greater than 1.

Find the nuclides with  $\beta^4n$  and  $\beta^3n$  and  $\beta n\alpha$  decay modes.

What can you say about the half-lives of these nuclides?

H4, H5, Li10, He7 are neutron emitters. What are their half-lives?

By using the Nucleonica option find their decay chains.

Neutrons emitters are resonance states of unstable nuclides; it means that some of the neutrons are not bound any more to the rest of the nucleus as it is for more stable nuclides. For this reason these neutrons and the nucleus can be seen as a nuclide only for a very short time. The limit between regular nuclides and resonance states is called the neutron dripline.

2. What is the decay mode of Ni56?

Find its decay chain.

Switch to the binding energy scheme chart.

Look at the binding energies of this decay chain. What can you say?

Switch to the spin/parity colour scheme. Find the spins of the nuclides involved in this decay chain.

3. Using the JAERI colour scheme, how many stable and primordial nuclides are in this database? What is the limit set for the half-life of the primordial nuclides?

Do the same work with the Karlsruhe nuclide chart scheme and with the "decay mode" filter.

4. It exists for some nuclides the possibility to emit light nucleus heavier than  $\alpha$  particles. This radioactive process is called "cluster emission" and was observed for the first time in 1984.

By using the filter option, looks how many nuclides experience this kind of radioactivity?

How many different kind of emitted nuclides can you find?

Choose two examples of nuclides which undergo this process and looks at the branching ratios of the main decay mode and of the cluster emission.

For Ba114 cross-check the information from Nucleonica and from the Karlsruhe Nuclide Chart.

5. Fertile isotopes are defined as isotopes with a long half-life and when submitted to a (n, $\gamma$ )

reaction, they produce a fissile isotope of a different element. Two well known fertile isotopes are

$^{238}\text{U}$  and  $^{232}\text{Th}$ . With the help of the nuclide chart give the nuclear reactions that lead from  $^{238}\text{U}$  to

$^{239}\text{Pu}$  and from  $^{232}\text{Th}$  to  $^{238}\text{U}$ .